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The Challenge of Change

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INSTITUTE OF PAPER SCIENCE AND TECHNOLOGY
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- to provide a multidisciplinary graduate education to students who advance the science and technology of the industry and who rise into leadership positions within the industry;
- to conduct and foster research that creates knowledge to satisfy the technological needs of the industry;
- to provide the information, expertise, and interactive learning that enables customers to improve job knowledge and business performance;
- to aggressively seek out technological opportunities and facilitate the transfer and implementation of those technologies in collaboration with industry partners.

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The Challenge of Change

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Abstract: Business globalization has become a dominant trend in most modern enterprises. The globalization of the pulp and paper industry has heralded new challenges and opportunities. Today's paper industry provides high-quality consumer products that are in worldwide demand and support the lifestyles of our new global economy. And yet, from these successes originate many of the current and future difficulties of the industry. Various paper industry leaders have stated that the capital requirements of manufacturing paper products are too high and are limiting creativity and the entrepreneurial spirit of the industry. Coupled with these challenges, the emergence of low-cost fiber resources outside the Northern Hemisphere has contributed to further pressures on the paper industry to significantly reduce its manufacturing costs through a major redesign of core manufacturing technologies. Within these difficulties are disguised but unparalleled opportunities for researchers to efficaciously develop new biotechnology-based processes for our industry. These new technologies must reduce the capital costs of pulp production, be readily implemented in the mill, and provide exceptional return for the resources invested if they are to be commercially feasible.

This paper will review the operational needs of the pulp and paper industry and how biotechnology can contribute to its future. The road to this future will entail the development of new global partnerships between industry, governments, and academic organizations. These new research partnerships will be linked together by the Web, co-ordinated by industry and government, and will utilize the best research expertise and facilities available in the world. These collaborative efforts will generate higher value fiber resources, lower total manufacturing costs, and develop new materials from which new products can be designed and manufactured. In summary, it is time to embark on this journey of change and biotechnology is well positioned to become a critical element in achieving industry success.

Introduction

The kraft pulp process[1] was invented in 1879 by the German chemist C. F. Dahl. This discovery was broadcast on Samuel F. B. Morris' "information superhighway" of the day, the telegraph. Interestingly, the telegraph system was patented 30 years before Dahl's discovery. The discoveries of the telegraph and the kraft process were quantum leaps in technology that contributed to the industrial revolution. These and other technological advances of the day significantly altered the development of Western civilization. Now, at the beginning of a new millennium, we are experiencing another dramatic change in modern society. The advent of inexpensive, powerful computers,

sophisticated software, and broadband telecommunications has begun to dramatically redefine our concepts of business, life styles, education, and government.

These technologies will significantly impact the pulp and paper industry. Although the decline in paper demand has been frequently forecasted as a result of Web-based commerce, analysis of worldwide paper consumption patterns indicates the opposite. For example, cut-size paper demand is rapidly increasing in response to the exponential growth of printer installations in commercial and residential settings. Furthermore, the growth of online retailers that ship directly to end customers such as Amazon.com and eToys will stimulate the demand for boxes and linerboard products. Despite these promising developments, the industry is also being challenged by a variety of economic changes that must be addressed. This paper highlights these challenges and how biotechnology could address these issues.

Discussion

Although Morris' telegraph gave way to telecommunication advances, the kraft process has remained the preeminent pulping technology. Indeed in 1997, American Forest & Paper Association reported that 83% of total world wood[2] pulp production could be attributed to the kraft process. The benefits of this technology versus other process alternatives are now well established and include:

- Excellent pulp strength
- Versatile raw material requirements
- Economic recovery of pulping chemicals
- Diverse paper products

Researchers over the past 121 years have dramatically improved Dahl's invention, yet the capital requirements for this process have increased. These studies have positioned kraft pulping and bleaching operations as mature commercial technologies. A technology life-cycle analysis of current kraft pulping and papermaking processes suggests that we are approaching a plateau in technology performance. Under these circumstances, marginal improvements in the manufacturing process will require substantial research resources.

Recently, the limitations of the kraft pulping process have begun to garner more attention. As discussed by R. Phillips,[3] there has been little progress in reducing the investment costs of most modern pulp and papermaking facilities, including those employing the kraft process. Indeed, the forest products industry has delivered only a 6% return on equity for most of the 1990's, which trails most other North American industries including chemicals, metals, and energy. This financial issue takes on additional importance since pulp and papermaking operations are one of the most capital-intensive in North America. In the past decade, these financial challenges have gained consequential significance due to the emergence of low-cost pulp producers in the Southern Hemisphere who can economically serve the world's markets.

As in Dahl's time, a recent confluence of events has necessitated the development of new breakthrough manufacturing technologies for the pulp and paper industry. These breakthrough technologies need to be revolutionary in design and operation and must positively impact:

- Raw material costs
- Manufacturing costs
- Energy costs
- Environmental performance
- Product quality

In addition, there is a strong need for new processes that would enable the development of new paper-based, higher-value products.

These challenges represent a unique opportunity for this scientific research community to re-invent the pulp and paper industry. For example, a doubling of the growth rates of Northern Hemisphere hardwoods and softwoods could decrease wood furnish costs by 10 –15%. New biopulping technologies could increase wood-free pulp yields by 10–20%. Breakthrough biopulping and biobleaching technologies could reduce the capital requirements for these operations by 50%. Finally, enzymatic fiber modification of pulp could readily reduce the amount of fiber needed to manufacture a sheet of paper by 20%. These few examples only scrape the surface of what could be accomplished in the future.

Certainly, the biotechnology revolution that is occurring in many mature industries suggests that we do not fully appreciate the potential of biotechnology in the pulp and paper industry. Nonetheless, it is now well established that most enzymatic systems are catalytic, highly selective, and operable under mild temperature and pressures. These features alone suggest that the development of biomanufacturing technologies for papermaking would be highly selective, have low capital requirements, and have substantially reduced operating costs.

The development of these new biotechnologies will require high-risk, high-payoff research programs that will necessitate a unique collaborative research effort between researchers, universities, research institutions, industry, and government. As in any endeavor of excellence, the team that possesses the best expertise and resources is most likely to be successful. Although a superficial examination of the research requirements needed to re-invent the paper industry may suggest that this is a Herculean task, in reality, the resources and expertise are available but dispersed worldwide and are diffuse in their research efforts. Fortunately, the revolution in multimedia communications now facilitates the development of national/international, cross-functional project-based teams that can answer these challenges.

Clearly, the last component in this vision is the need for research funding. Although this issue appears to be a daunting challenge, we believe that this task is readily possible for an industry that provides employment for approximately 1 million people and $12 billion on capital projects for 1997-98 in North America. These societal benefits, coupled with

the industry's environmental stewardship, strongly supports the development of a partnership between industry and government to fund high-risk, high benefit research in pulp and paper. Indeed, the Agenda 2020 Research Program, sponsored by the United States Department of Energy Office of Industrial Technology in collaboration with the American Forest and Paper Association, is a model of what can be achieved. The challenge of this conference to begin the development of centers of excellence focused on developing breakthrough pulp and papermaking biotechnologies that will revolutionize our industry. Then, in the spirit of Ray Kinselles (Kevin Costner) in the Field of Dreams, we could say "if you build it [the funding] will come". However, we can be more confident than that due to a significant effort by the Chief Technology Officers of the AF&PA companies who have undertaken an effort to define the most critical needs of the paper industry, to develop bold and aggressive programs, and to help attract the major funding needed to make it happen. With this emerging support from these paper industry leaders, we are on the verge of a new research era in this industry. It is time to dramatically change the core process technologies of this industry. It is time for biomanufacturing to step forward with a bold plan.

Conclusions

In summary, it appears that history is now ready to repeat itself. A confluence of scientific accomplishments in chemistry, communications, and business in the late 1800's set the stage for the discovery of the basic pulp manufacturing technologies currently employed.

In this new millennium, we now have unprecedented developments in genomics, biotechnology, telecommunications, computational modeling, process chemistry, and engineering. These advanced technologies and the researchers in this audience have the potential to redefine our industry to provide a new, competitive, environment-compatible manufacturing technology for the world's paper industry based on renewable, natural resources.

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[1] Dahl, C.F., U.S. Patent 296, 935 (Apr. 15, 1884).
[2] 1998 Statistics – Data Through 1997, Paper, Paperboard & Wood Pulp. American Forest & Paper Association. Washington, DC.
[3] Phillips, R.B., "Research and development in the pulp and paper industry: Year 2000 and beyond." TAPPI J., 1, 42(2000).